AEI ORTHOTRON

LINEAR ACCELERATOR

SERIES III

Associated Electrical Industries Ltd.

Instrumentation Division

Barton Dock Road

Urmston, Lancs.

Publication 2086-51

ASSOCIATED ELECTRICAL INDUSTRIES LTD.

INSTRUMENTATION DIVISION.

TECHNICAL INFORMATION

ON THE

AEI SERIES III ORTHOTRON

November 1962

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ASSOCIATED ELECTRICAL INDUSTRIES LIMITED

Specification

SERIES III LINEAR ACCELERATOR

The Series III Clinical Linear Accelerator is a compact supervoltage X-ray generator with a high X-ray output and is designed to give the greatest possible reliability in service. The treatment unit is in a single ended gantry mounting and is capable of rotation through 370° without needing a pit in the floor to accommodate the swinging arm. The overall height of the unit is 7 ft $11\frac{3}{4}$ in with the axis of rotation 4 ft 0 in above floor level. This height permits treatment when directing the beam from underneath a patient lying on the couch which is designed to allow all angles of treatment without appreciable interception of the beam.

To minimise setting up time we preserve the isocentric feature which has proved so successful in our earlier clinical accelerators. The centre line of the X-ray beam intersects the horizontal axis of rotation of the treatment unit and is always normal to it. The vertical axis of rotation of the treatment couch assembly also passes through this same point, the isocentre. The distance between target and isocentre is one metre. According to the treatment used, the isocentre can most usefully be the centre of the field at the point of entry on the skin or the centre of the tumour being treated.

In order to combine 370° rotation of the treatment unit with the isocentric feature a special design of turntable is employed where the couch ram is mounted off the isocentre, but the centre of rotation of the turntable is on the isocentre vertical axis. A clear space of 4 ft 11 in between the central plane of the X-ray beam and the base of the treatment unit enables the couch to be freely rotated. The vertical movement of the couch ram is motorised and has fast and slow speeds.

X-Ray Beam

The equipment is intended normally to run at a dose rate of 200 r/min at 1 metre with beam flattening filter in position. The flattening filter gives uniform intensity over a field of 31.5 cms diameter at 1 metre from the target. The minimum field size is 1 cm x 1 cm and the maximum field size is 30 cms x 25 cms with slightly rounded corners defined by the fixed X-ray collimation giving a circular field of 31.5 cm diameter. The energy can be specified to be either 5 MeV or 6 MeV when a machine is ordered. The maximum output of the equipment is over 350 r/min.

Electron Beam

The Series III Accelerator as normally furnished does not provide for extraction of the electron beam. If required, provision can be made to bring out the electron beam in line with the accelerating structures through a thin window, and additional facilities, referred to later, can also be provided.

Auxiliary Apparatus

The complete equipment comprises treatment unit, couch turntable assembly, modulator cubicle, focus supply cubicle, control desk and miscellaneous equipment cubicle. The modulator and focus supply cubicles normally stand to the sides and rear of the treatment unit in otherwise unoccupied and useless space. The control desk, from which the radiographer operates the equipment, is normally placed near a viewing window and the entrance to the treatment room. The miscellaneous equipment cubicle can be placed in any available space, even at a considerable distance from the treatment unit if necessary.

TECHNICAL SPECIFICATION

Treatment Unit

Electron Energy	5 MeV or 6 MeV at Customer's choice on ordering.
X-ray output (flattened)	Two preset dose rates are available and can be chosen by a switch on the control desk. A low rate of approximately 30 r/min at 1 metre is obtained at a pulse repetition rate of 50 p.p.s. A high dose rate which would normally be set to 200 r/min at 1 metre is obtained at a pulse repetition rate about 300 p.p.s.
Pulse length and repetition rate.	2 μs electron pulse continuously variable from 50 to 500 p.p.s.
Focal spot	X-ray and Electron Collimation to 5 mm . Effective spot size less than 5 mm diameter.
Dose and Dose Rate Measurements.	Duplicate metal ionisation chambers.

Front Pointer	Optical and mechanical.
Back Pointer	Optical or mechanical.
Field size indicator	Optical
Angular velocity of Treatment. Unit.	Continuously variable up to 1 r.p.m.
Height of rotation	Axis of rotation of machine 4 ft 0 in above finished floor level.
Angle of rotation	370° on a flat floor.
Isocentric Error	Maximum error in any position 1.5 mm
Floor loading	Total weight of Treatment Unit 5 tons taken on a flush mounted steel bed plate.
Overall size of Treatment Unit alone when installed.	10 ft 5 in long x 3 ft 0 in wide x 7 ft 11¾ in high
Width with modulator and focus supply cubicles in position.	7 ft 11 in.

Treatment Couch

Couch top width	2 ft 0 in
Couch top length	7 ft 0 in
Lateral movement	± 6 in
Longitudinal movement	3 ft 7 in
Vertical movement	1 ft 6 in
Height of couch top fully raised.	4 ft 0 in
Angle of rotation (Ram)	180°
Angle of rotation (Turntable)	360°

Vertical lift of couch ram by Motor Driven Screw Jack

Manual rotation of the Turntable and Couch Ram.

Final adjustment of couch top longitudinally and laterally by handwheels.

Couch Top

Construction is indicated in drawing A2189689 and takes the form of a central 'I' beam with several cross members. The couch top is fitted with removable laminated wood panels. The overall cover is a stretched plastic (Melinex) sheet and thus uninterrupted upward treatment can be given. The couch top and float table are removable and interchangeable as referred to later.

Waveguide

The accelerating waveguide is mounted in the horizontal arm of the treatment unit and bending magnet system is used to bend the electron beam along the drift tube and focus it on to the target.

The waveguide construction uses previously well proved techniques and due to the elimination of r.f. feed back several simplifications have been found possible. An approach to sealed-off vacuum technique has been made, but by using an ion pump to evacuate the small vacuum system (20 litres) and incorporating a demountable electron gun it is still possible to change gun cathodes in situ without removal of the waveguide from the gantry. The improved vacuum allows the use of a long-life dispenser type cathode developed for use in small sealed klystron valves. In such applications, lives up to 10,000 hours have been reported. Tests of such cathodes in our Laboratory using ion pumping have shown lives in excess of 1,000 hours.

The magnetron, which is easily changed when necessary, is the 2 MW AEI type BM 1001. The general use of this valve in the AEI Series I and Series II Linear Accelerators has resulted in a long life expectancy and it carries a guarantee of 250 H. T. hours. The BM 1001 is a tunable version of the well-tried type VX 4061. Magnetron tuning is achieved by a single motor operated from the control desk and frequency indication is given on a meter at the desk. Thus the difficult two variables frequency control technique of previous machines has been eliminated. Broad band matching of the waveguide together with the use of an isolator give easy running conditions for the magnetron with greater life expectancy for what has previously been the main replacement component.

Setting up Facilities

1. Mechanical front and back pointers are directly mounted on the fixed framework of the machine and incorporate telescopic spherically tipped rods.
2. An optical system defining the treatment field is provided. Alignment of this with the X-ray field is easily done by the use of three simple independent controls.
3. Optical definition of the 1 metre F.S.D. centre point is obtained by four projected light beams converging to an overlapping 3 mm diameter spot.

Treatment field size is set by diaphragms supported by a double linkage system so as to move as though pivoted about the target. Field size at 1 metre F.S.D. is indicated by scale.

Rotational movement of the gantry is by D.C. motor with continuously variable speed drive from Zero up to 1 r.p.m., operated from a joy-stick mounted on a small mobile control pedestal. Vertical movement of the couch is motorised and is controlled from push-buttons on this same pedestal. Horizontal movements of the couch top are made easy by roller action and prior to application of the brakes the final exact positioning is done by hand wheels.

The X-ray Head is more slender than on the earlier Series I and Series II Linear Accelerators, whilst still reducing the radiation level outside the field area to 0.1% of the intensity on the axis and designed to meet the British Ministry of Health Specification. ~~The arrangement is shown in drawing A2189842 which is attached.~~ The diaphragms normally are hand controlled at the X-ray Head. Motorised diaphragms can be provided as a special requirement.

Control Desk

The controls for treatment, which the Radiographer operates, are mounted on a sloping panel of a simplified control desk. They include, on-off buttons, dose and dose rate indication, pre-set dose decade switches and indicator lights.

The controls and monitoring for daily running up or servicing by the technician are in a separate part of the control desk.

A drawing of a typical control desk is attached, but this can be made to be the mirror image of that shown.

If the optional extra controls are not required, or if these can be mounted elsewhere, it is also possible to eliminate one third of the rear panel and this enables the desk to be mounted below a viewing window. Other variations of the desk are possible to suit a particular installation.

The indication of integrated dose is normally by means of a large meter. Should digital indication be preferred, a digital voltmeter can be substituted for this meter. The dose would still be set by decade switches which of course retain the original setting of the dose required.

Technicians controls consist of all requirements for tuning and setting up the accelerator. In addition, a series of signal output and monitoring points are provided under a protective cover for checking modulator wave forms, etc. These jack-points are used in connection with a standard oscilloscope.

Installation

A great degree of flexibility is possible in the layout of the apparatus.

In addition to the treatment unit and control desk, there are three cubicles. These are a modulator, a focus coil supply unit and a miscellaneous unit containing water pump, water tank, refrigerator, electrical stabilising and distribution panel, etc. ~~(refer sketch drawing SK.1739806 for physical dimensions).~~

The focus supply cubicle is most conveniently placed along side the treatment unit and the modulator can be placed in a similar position on the opposite side of the treatment unit, as shown in the line drawings. With some advantage however, the modulator may be installed outside the treatment room in a small apparatus room or possibly near the control desk. The miscellaneous cubicle can be placed in any available space within reasonable distance of the treatment room.

OPTIONAL EXTRA EQUIPMENT

Trolley, Chair and additional Couch Top

For ease of patient handling, it is possible to load the patient on to the couch with the latter in its lowest position (2 ft 6 in above floor level).

If required, the couch top with the float table can be slid from a trolley on to the couch ram. An additional couch top and float table can be provided so that setting up of the patient can be arranged outside the treatment room. A treatment chair can also be provided, if required, and this may be substituted for the couch top.

Electron Extraction

The electrons after acceleration are normally brought on to the X-ray target by a combined focussing and beam bending magnet system.

If required for electron therapy, the electron beam may be brought out in line with the accelerating wave guide through a specially designed thin window.

The magnet is switched off under these conditions, a lead plug is removed, and protective circuits are brought into operation. Additional facilities can be attached to the X-ray head to suit the requirements for a particular installation. One possible facility is an additional bending magnet to bring the electron beam to a new isocentre over the couch ram centre line.

Wedge Filter Interlock Circuit

A wedge filter interlock circuit can be provided to check that the correct wedge has been inserted and also to check that the wedge has been correctly orientated in the X-ray head.

The orientation of the wedge is recorded at the control desk and a number of circuits, usually 6, are incorporated between the control desk and the storage trays (for the wedges) which are usually located at a convenient position in the treatment room. This automatically provides a double check on the treatment techniques being employed.

Arc Therapy

Provision can be made, if required, for facilities for arc therapy including provision for switching off the X-ray beam at the end of a selected arc. This includes servo control of the angular velocity of the treatment unit from the X-ray beam intensity ensuring delivery of any required uniform dose per unit of angle throughout the treatment arc.

During operation, the angular position of the treatment unit is indicated both in the treatment room and on the control desk.

Electrical Power and Water Consumption

Installation requirements call for a 25 kW supply terminated with a 60 amp switch fuse unit. This allows for switching surges, regulation, etc. Actual consumption is much less. During exposure, consumption at maximum output is approximately 12 kW but in between exposures, consumption will be 1-2 kW. During overnight stand-by conditions, power consumption is negligible.

The water cooling arrangements are self contained and no water is wasted to drain. Cooling is by a sealed unit refrigerator, heat being conducted from the refrigerator condenser by ambient temperature air flow. An additional water cooled heat exchanger is provided and where a cold water supply is available, this can be used to reduce the load on the refrigerator and to provide stand-by cooling when required.

LINEAR ACCELERATORS ALREADY INSTALLED

The design of our new equipment has been arrived at after many years' experience in this field. Installations to date are as follows:-

Hammersmith Hospital, London, England	Original 8 MeV, first medical linear accelerator.
Christie Hospital, Manchester, England	4 MeV Series I

Mount Vernon Hospital, London, England	4 MeV	Series I
Western General Hospital, Edinburgh, Scotland	4 MeV	Series I
Queensland Radium Institute, Brisbane, Australia	4 MeV	Series I
Peter MacCullum Clinic, Melbourne, Australia	4 MeV	Series I
The Royal Adelaide Hospital, Adelaide, Australia	4 MeV	Series I
Auckland Public Hospital, Auckland, New Zealand	4 MeV	Series I
Institute of Radiotherapy, Perth, Australia	4 MeV	Series I
Cookridge Hospital, Leeds, England	4 MeV	Series II
Christie Hospital, Manchester, England	4 MeV	Series II
Whitchurch Hospital, Cardiff, Wales	4 MeV	Series II
Western Infirmary, Glasgow, Scotland	4 MeV	Series II
Belvidere Hospital, Glasgow, Scotland	4 MeV	Series II

PROVISIONAL

INSTALLATION REQUIREMENTS

FOR

SERIES III LINEAR ACCELERATOR

INTRODUCTION

The following notes cover various points concerning the installation of the Series III Linear Accelerator.

1. DESCRIPTION

Technical details of the performance of the machine are outlined in the attached Provisional Specification. A Schedule of Dimensions and Weights of the various units is appended at the end of this text, and Outline Drawings are also attached.

2. LAYOUT

Drawing A2189689 shows an outline of the Series III Linear Accelerator. Drawing A2189386 shows a single entry layout of minimum possible size.

Three cubicles and a Control Desk are required in addition to the Treatment Unit. The cubicles are:-

Modulator Cubicle

Focus Cubicle

Miscellaneous Equipment Cubicle

In the drawings the Modulator Cubicle and Focus Cubicle are shown on either side of the Treatment Unit but the Modulator Cubicle could be positioned outside the Treatment Room. The Miscellaneous Equipment Cubicle contains water pump, water tank, refrigerator and electrical stabilising and distribution panel and can be positioned in any available space near to the Treatment Room, or even at a considerable

distance away if necessary.

The control desk may be installed in an entrance hall or a special control room at choice. It is usual practice to ensure that the radiographer, when seated at the control desk, can keep under surveillance the patient undergoing treatment (via the viewing window) and the entrance to the Treatment Room.

Drawing A2189689 shows details of the floor loading. Pits and service ducts are required for installation of the machine and the major requirements are:-

a. Recess for the Treatment Unit baseplate.

b. Pit for the couch turn-table assembly.

c. Service ducts or channels.

(a) The pit for Treatment Unit is 1 ft 3 in deep x 3 ft 8 in wide this should extend for approximately 9 ft 6 in. This length gives a space of 6 in at the front of the treatment unit base plate, which is 6 ft long, and a space of 3 ft between the rear of the treatment unit base and the wall behind the unit.

The Treatment Unit is bolted on to a level surface formed by three 6 in x 5 in rolled steel joists fitted with machined flanged plates 1 in thick (these joists are provided by AEI and fixed by the building contractor under AEI supervision). The loading on these beams is 2, 2 and 1 ton respectively, from front to back of the Treatment Unit.

(b) The pit for the couch turn-table assembly is 1 ft 8 in deep x 4 ft 6 in diameter.

(c) Service ducts or channels are required between the Control Desk, the Treatment Unit, the Couch Turntable Assembly, the Miscellaneous Equipment, and if the Modulator is installed in a separate room, between the Treatment Unit and the Modulator. These ducts should preferably take the form of steel pipes laid direct in the concrete during pouring and where the pipes terminate in pits they should protrude approximately 1 in to enable earthing strap to be fitted.

A typical arrangement, for example, would be to arrange that a 6 in diameter service pipe is laid between the control desk and treatment unit and a 7 in diameter pipe is laid between the Treatment Unit and the Miscellaneous Equipment Unit and Modulator.

The choice of finish for the Treatment Room floor is of course decided by the customer. It should be noted that removable floor panels are required around the base of the Treatment Unit. Angle strips are provided on the Treatment Unit to support the removable panels and we suggest that the Architect should provide an angle trim around all floor openings except the couch pit where AEI will provide an engraved scale.

All floor pits should be drained. A pump should be provided if there is no direct drainage on site.

3. INSTALLATION

The Treatment Unit will normally be shipped as a complete unit in order to minimise installation time.

It is desirable that the dimensions of the outer door and any entrance corridor should be such as to enable the unit to be brought directly into the Treatment Room.

3.1. Access for Machine

If a labyrinth type layout is used and the dimensions of the corridor and entry into the Treatment Room are at least those in drawing A2189386, the Treatment Unit can be brought in along the corridor, provided floor strengths allow this. On the other hand, if this method of installation is not possible then a temporary access opening 9 ft 6 in high x 5 ft 0 in wide clear through should be left in one of the walls of the Treatment Unit. This opening provided for access should be filled in after checking of the accelerator for damage in transit. AEI request that the installation opening in the outside wall be provided with a lockable dust-proof temporary door after the accelerator has been taken into the Treatment Room. After installation the opening can be filled in either by pre-cast concrete blocks of suitable shape to prevent straight-through X-ray leakage or, alternatively, the upper edge of the opening can be splayed at 45^{o} outwards to allow concrete to be poured and a mechanical agitator to be used.

3.2. Finish of Rooms prior to Commencement of Installation

Treatment Room:	Final finish unless opening left in wall in which case:- Painting to undercoat stage. Temporary linoleum on floor. Heat and lighting available in both cases.
Control Room:	Final finish. Power points heat and lighting installed and working.
Room(s) for Miscellaneous Equipment Unit or Modulator Cubicle.	Final finish. Power points heat and lighting installed and working.

4. PROTECTION

The customer, in conjunction with his Architects, is responsible for the design of the Treatment Room to afford adequate X-ray protection. The Company can advise, if requested, on the required thicknesses of walls, arrangement of entrances, viewing windows etc. for any desired layout. They will be glad to supply a copy of Research Report T. P. /R. 5314 on 'The Shielding of Treatment Rooms for Linear Accelerators'. The design of the rooms may be affected by the proximity and use of adjacent rooms and buildings.

For the purpose of preliminary planning, it may be helpful to know that any wall which is in the direct line of the X-ray beam should be built of good quality concrete of density 2.3 to a thickness of about 5 ft 6 in; this thickness may be slightly increased or decreased depending on the distance of the Treatment Unit from the wall in question and the minimum radiation level which can be tolerated outside the Treatment Room and will be 6 in greater for a machine of 6 MeV compared with the figure for a 5 MeV machine.

The wall between the Treatment Room and the Control Room and the wall between the Treatment Room and any apparatus room which may be felt to be required, should be at least 2 ft 8 in thick, based on concrete of density 2.3.

The Series III Linear Accelerator is capable of rotation through 370^{o} and hence it is possible to direct the beam directly upwards. Therefore, any part of the roof which is in the direct line of the X-ray beam should be built of good quality concrete of density 2.3 to a thickness of about 5 ft 6 in. If a thin roof is accepted by Customer, suitable means must be provided to precent access during periods when the Accelerator may be running.

The Series III Linear Accelerator is offered with an optional facility for extraction of the electron beam. If required, the electron beam is brought out in line with the accelerating waveguide structure through a thin window.

If the electron facility is required the wall thickness must be considered from this standpoint but the wall thickness details given above are based on a machine being used for X-ray therapy only.

The wall thicknesses stated above have been planned on the assumption that exposure will be continuous. Although the exposure in clinical use is not continuous, this does not mean that the protection should be reduced as occasional non-clinical use may be required.

Ducts for cabling, heating and ventilation must be arranged in such a way as to avoid possible weak points in the X-ray protection, particularly where these ducts are brought through the wall, or where chasing of the concrete is required.

Various forms of viewing, such as periscopes, solid glass windows laminated plate glass windows and liquid windows, have been used in Linear Accelerator installations. Suitable solid glass windows of reasonable size are now available, or alternatively, a suitable liquid window can be supplied by the Company. Closed loop T.V. is now available at a reasonable price and can be used instead of, or to augment window viewing; it may be used to give a close-up of the treated area.

In designing the entrance to the Treatment Room, it is necessary to arrange the labyrinth so that no X-rays from the accelerator can emerge from the room, without having been scattered at least twice from the internal walls. Whilst it is possible to design the labyrinth so that doors for the Treatment Room are unnecessary for protection, it is advisable to provide some form of barrier to prevent unauthorised access to the Treatment Room, particularly while the machine is running. This barrier may take the form of a normal door. Alternatively, a photo-electric warning beam system can be used, but it is suggested that this arrangement should only be employed when the entrance to the Treatment Room is also directly visible from the control desk.

5. ELECTRICITY SUPPLY

The following notes define the work to be carried out by the electrical contractors.

The accelerator requires an electrical supply from a 60 amp switch fuse unit to be supplied and fixed by the electrical contractor in a suitable position adjacent to the Treatment Room. The lead to the switch fuse unit should be brought, as an independent supply, direct from the switch fuse or circuit breaker in the sub-station.

The contractor is also responsible for providing the four core cable (3 ph and N) between this switch fuse unit and the miscellaneous unit together with a solid earth connection (less than 1 ohm resistance to earth) to which AEI will bond their equipment by a 1 in x 0.06 in copper busbar. The switch fuse unit should be fitted with 40 amp fuses and the cable should be rated for this current. This is to cover both the accelerator load and additional power sockets provided for servicing and physicist's use on the equipment.

The interconnections between the various items of the accelerator equipment will be supplied and fitted by AEI.

Lighting and general supplies for the Treatment Room should be on a separate feed.

The supply required for the accelerator is 415 volts, 50 cycles per second 3-phase, 4-wire, 25 kW.

The supply to certain parts of the equipment is stabilised by a "Breco" 3 phase voltage regulator which is located in the 'miscellaneous equipment' cubicle and which provides a 3-phase voltage of 415 volts (neutral brought out) ± 1% for an input variation of ± 10% from the nominal voltage. AEI must be advised if the above variation of ± 10% is likely to be exceeded, or if the standard voltage is different from 415 volts. Unusual supplies can be catered for if stated at the time of placing an order.

The electrical contractor is to provide all lighting circuits, heating circuits, power points, room warning lights and safety interlock circuits. The wiring for the last two items should be brought to a terminal box adjacent to the control desk. AEI will be responsible for wiring between this terminal box and the desk. Three power points of 10 amp rating are provided on the equipment as mentioned earlier.

In order to avoid weakening of the X-ray protection, it is important not to drill unnecessary holes in the concrete. Apart from the leads for the Linear Accelerator equipment itself, only one power entry point should be made into the Treatment Room.

6. COOLING SYSTEM

The Linear Accelerator has a closed system of water cooling and temperature stabilising, and is supplied with a refrigerator incorporated in the Miscellaneous Equipment Unit. The rating of this refrigerator enables it easily to handle clinical use of the machine at any ambient temperature.

An additional heat exchanger is provided through which cold water may be passed if available. This allows continuous running of the machine for any special experiments or for the refrigerator to be taken out of service at any time.

For either of these purposes a supply of 5 gallons of water per minute at less than 20°C is required. A rather smaller supply is adequate for servicing purposes such as flushing out the water system periodically. A drain capable of handling 5 gallons per minute is required adjacent to the Miscellaneous Equipment Cubicle. Unless the local water supply is very low in mineral content it is advisable to fill the closed system with distilled water not mains water.

7. VENTILATION

The Linear Accelerator does not give rise to any residual (i.e. radioactive) hazard, so that there is no danger from airborne material carried through the ventilation ducts.

As already mentioned, the ducts should be so arranged as not to cause gaps in the X-ray protection of the Treatment Room.

The Linear Accelerator itself will operate satisfactorily in air conditions which are suitable (both as regards temperature and humidity) for patients.

It is necessary for the Architect to arrange for suitable ducting to be provided for cooling the refrigerator. Two ducts, each approximately 1 sq ft. in area and capable of passing 1000 cu. ft. of air per minute are required.

8. INTERCOMMUNICATION

It is suggested that the house telephone system includes an extension to the control room and, if in use, an apparatus room. Intercommunication between these rooms is desirable.

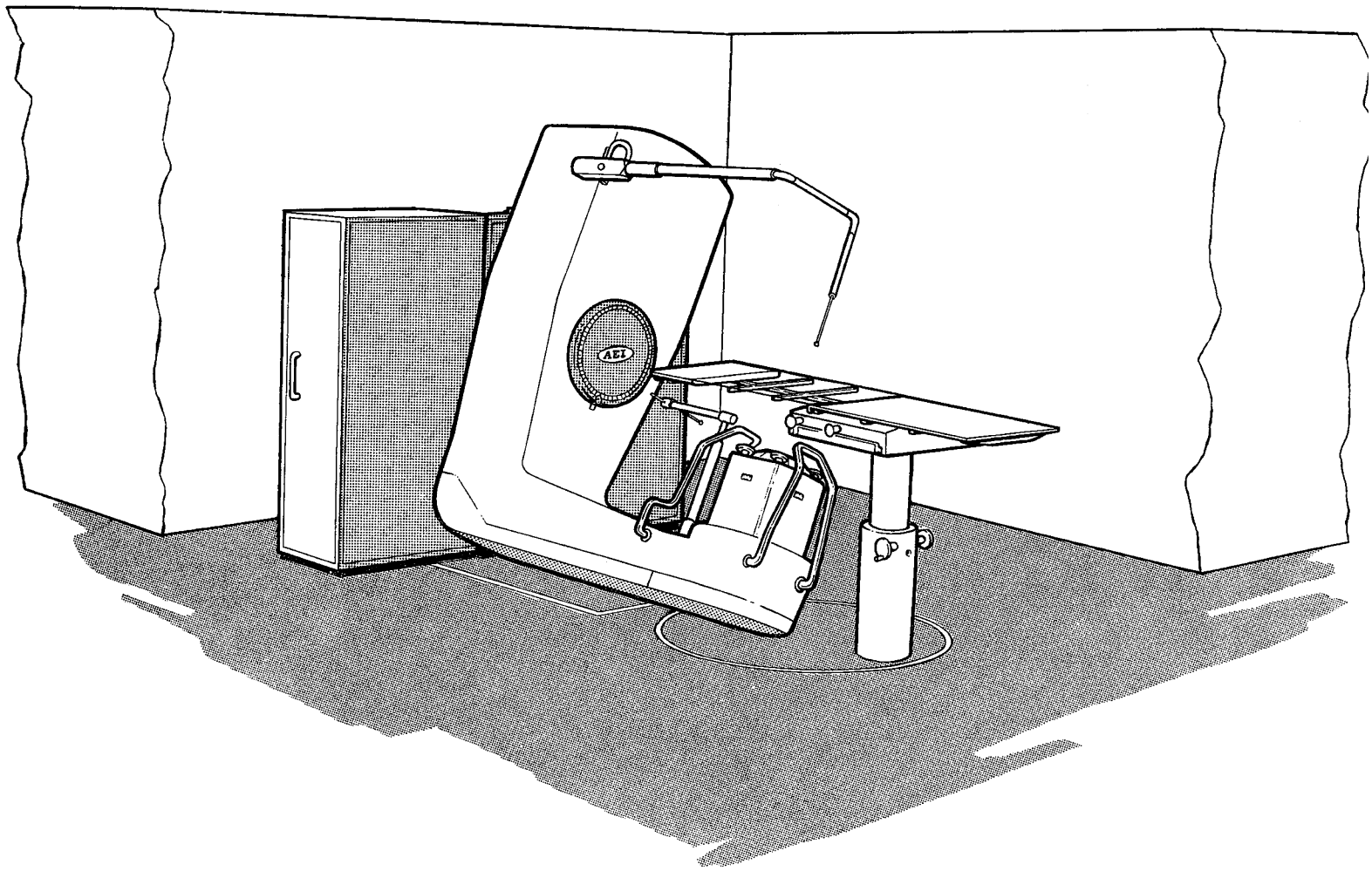
9. INTERLOCK SYSTEM AND WARNING LIGHTS

Warning lights should be provided above the entrance(s) into the Treatment Room; these lights, together with the cabling thereto, are to be provided by the electrical contractors. A 240 volt supply of 5 amp rating is provided from the Linear Accelerator Unit, which is energised when the Accelerator is running.

Interlock switches, or equivalent, should be provided at the entrance(s) of the Treatment Room, so as to switch off the Accelerator if any unauthorised attempt is made to enter the room whilst the Accelerator is running.

SCHEDULE OF APPROXIMATE DIMENSIONS AND WEIGHTS

Unit	Length	Breadth	Height	Weight (Tons)
Treatment Unit	10 ft 5 in	3 ft 0 in	7 ft 11¾ in	5 approx.
Control Desk	5 ft 3 in	2 ft 6 in	3 ft 4 in	0.25 "
Modulator Cubicle	2 ft 0 in	2 ft 11 in	6 ft 3 in	0.8 "
Focus Supply Unit	2 ft 0 in	2 ft 11 in	6 ft 3 in	0.4 "
Miscellaneous Equipment	4 ft 1 in	3 ft 0 in	6 ft 4 in	0.4 "
Couch turntable Assembly	4 ft 6 in diameter		1 ft 6 in	0.25 "



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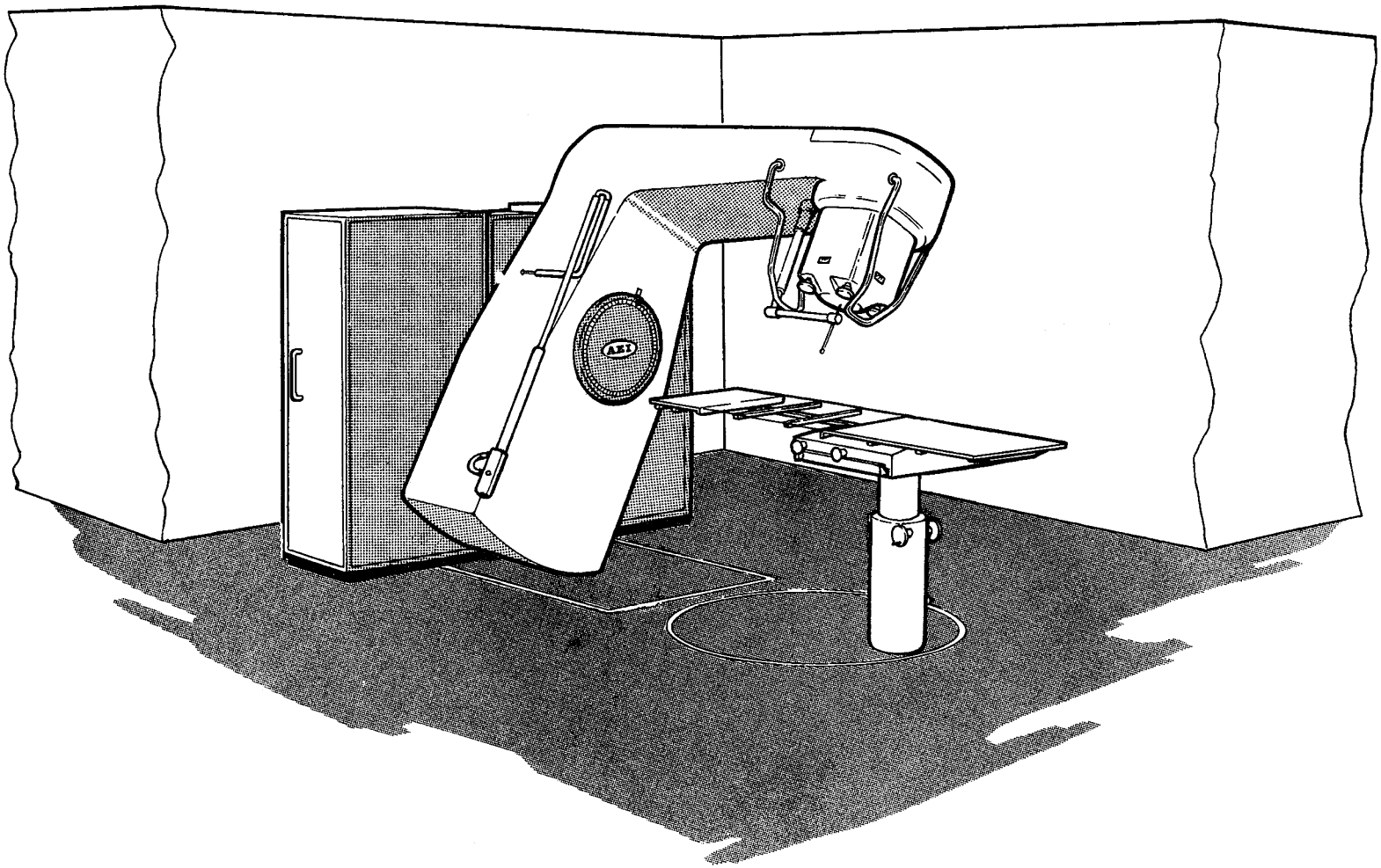

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